

## Unit 13 – The Urinary System

Pleasant Valley High School  
Anatomy and Physiology

### 17.1 Introduction

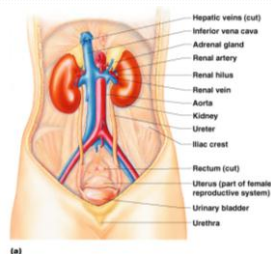
### Functions of the Urinary System

- Elimination of Waste Products
  - Nitrogenous Waste (Urea)
  - Toxins
  - Drugs
- Regulation of Homeostasis
  - Water Balance
  - Electrolytes (salts)
  - Acid-Base balance in the blood
  - Blood Pressure
  - Red Blood cell production
  - Activation of Vitamin D

### Organs of the Urinary System

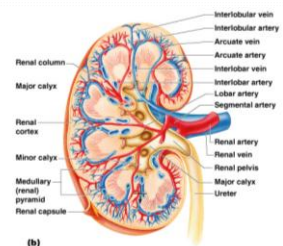
### Organs Overview

- Kidneys
- Ureters
- Urinary Bladder
- Urethra\*



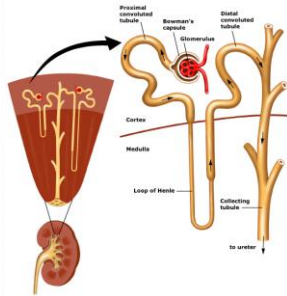
### Regions of the Kidney

- Renal Cortex – outer region
- Renal Medulla – inside the cortex
- Renal Pelvis – inner collecting tube, leads to ureter
- Medullary Pyramids – triangular region of tissue in the medulla
- Calyces – cup shaped structures that funnel urine towards the renal pelvis (major and minor)

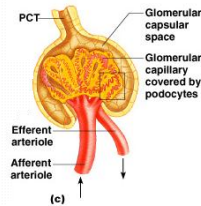


## Nephrons

- Functional unit of the kidney
- Responsible for forming urine
- Main structures of a nephron
  - Glomerulus
  - Renal Tubule



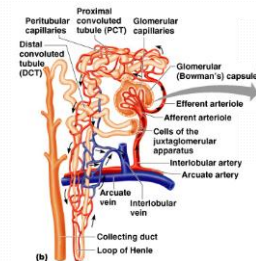
## Glomerulus



- Specialized capillary bed
- Attached to arterioles on both sides
  - Afferent arteriole – large diameter, blood goes in
  - Efferent arteriole – narrow diameter, blood leaves
- Capillaries are covered with podocytes from the renal tubule
- Glomerulus sits within the glomerular capsule (first part of the renal tubule), can be called *Bowman's capsule*

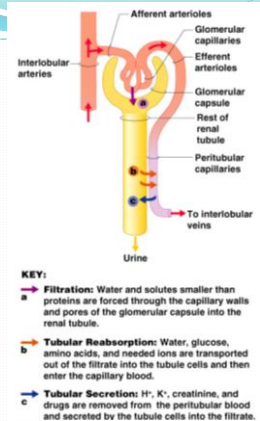
## Renal Tubule

- Leads to the glomerular capsule
- Proximal convoluted tubule – coiled portion
- Loop of Henle – curves back towards the top
- Distal convoluted tubule – coiled portion



## Urine Formation

- 3 steps
  - Filtration
  - Reabsorption
  - Secretion



## Filtration

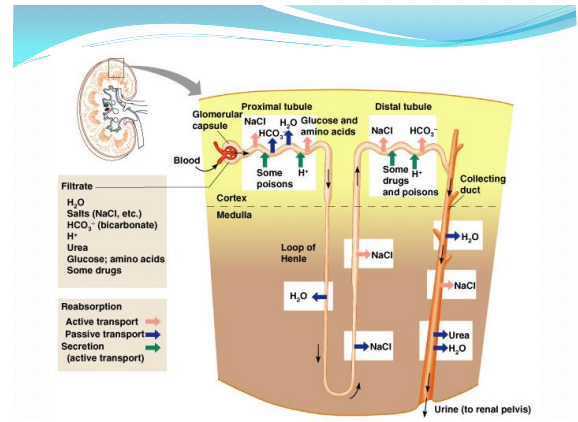
- Nonselective passive process
- Water and solutes smaller than proteins are forced through capillary walls
- Blood cells cannot pass out of the capillaries
- Filtrate is collected in the glomerular capsule and leaves via the renal tubule

## Reabsorption

- The peritubular capillaries reabsorb several materials, these items will not be found in urine
  - Some water
  - Glucose
  - Amino acids
  - Ions
- Some reabsorption is passive, but most is active
- Most reabsorption occurs in the proximal convoluted tubule
- Materials that are not reabsorbed, these items will be found in urine
  - Nitrogenous waste (Urea, Uric Acid, Creatine)
  - Excess Water

## Secretion

- Some material moves from the peritubular capillaries into the renal tubules
  - Hydrogen and Potassium Ions
  - Creatine
  - Drugs
- Material left in the renal tubule moves towards the ureter and becomes urine

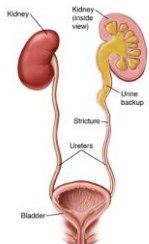


## Characteristics of Urine for Medical Diagnosis

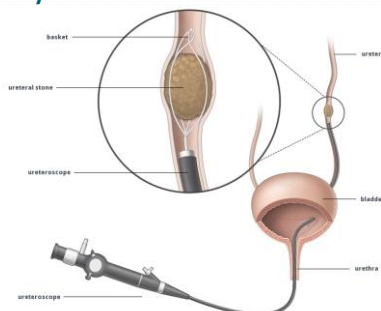
- Colored – somewhat yellow due to the pigment urochrome (produced when hemoglobin is destroyed) and solutes
- Sterile – should be free of microorganisms
- Slightly aromatic
- Normal pH of around 6

## Ureters

- Slender tubes attaching the kidney to the bladder...two of them...one from each kidney leading to ONE urinary bladder
  - The tubes collapse
  - Continuous with the renal pelvis
  - Enter the posterior of the bladder
- Peristalsis aids gravity in urine transport

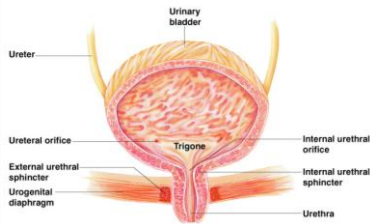


## Kidney Stones?



## Urinary Bladder

- Smooth, collapsible sac
- Temporarily stores urine
- Trigone – three openings: two from ureters, one to the urethra
- The Wall
  - The layers of smooth muscle: detrusor muscle
  - Mucosa made of transitional epithelium
- The bladder can expand slightly without increasing internal pressure



## Urethra

- Thin walled tube that carries urine from the bladder to the outside of the body through peristalsis
- Release of urine by two sphincters (internal urethral sphincter is involuntary, external urethral sphincter is voluntary)
- Gender Bias
  - Males
    - Carries urine and is a passageway for sperm cells
    - Long, and travels through the external structure of the penis
  - Females
    - Carries only urine
    - Completely internal and is very short

## The Urethra



## Micturition (voiding)

- Both the internal and external sphincters must open in order to allow voiding of the bladder
  - The internal sphincter is relaxed after the bladder is stretched
- Activation is from an impulse sent to the spinal cord and then back to the pelvic splanchnic nerves
- The external urethral sphincter must be voluntarily relaxed

## Maintaining Water Balance

- Normal amount of water in a human body
  - Young adult females – 50%
  - Young adult males – 60%
  - Babies – 75%
  - Old age – 45%
- Water is necessary for many body functions and levels must be maintained

## Salt and Water: The Odd Couple

- Changes in electrolyte balance causes water to move from one compartment to another
- “Where the salts go, the water must follow”
  - Alters blood volume and blood pressure
  - Can impair cell activity

## Water Balance

- Water intake must equal water output
- Sources of water intake
  - Ingested food and fluid
  - Water produced during metabolic processes (water weight)
- Sources of water output
  - Vaporization out of the lungs
  - Lost in perspiration
  - Leaves in feces
  - Urine production

## Electrolyte Reabsorption

- Regulation primarily through hormones
  - ADH – antidiuretic hormone, prevents excessive water loss through urine
  - Aldosterone regulates sodium ion content of extracellular fluid
- Cells in the kidneys and hypothalamus are active monitors of the water:electrolyte balance

## Maintaining Blood pH

- Blood pH must be between 7.35 and 7.45 to maintain homeostasis
  - Alkalosis – pH above 7.45
  - Acidosis – pH below 7.35
- Most ions originate as byproducts of metabolism
- Most pH balance is maintained by the kidneys
- Other pH controllers
  - Blood buffers
  - Respiration